

A new coral inhabiting barnacle of the genus *Chionelasmus* (Cirripedia, Balanomorpha) from New Caledonia, Southwest Pacific

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*Dans le champ de l'observation,
le hasard ne favorise que les esprits préparés.*
(Louis Pasteur, 1854)

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ABSTRACT

This paper describes *Chionelasmus crosnieri* n.sp., from a guyot on the northern part of Norfolk Ridge, to the south of New Caledonia. This new species, within the previously monospecific genus *Chionelasmus*, inhabits a living octocoral, *Muricides* sp. indet. Comments on the distribution and habitat of the new species are provided, including a proposal for the method by which the cyprid larva of *C. crosnieri* gained access to the axial skeleton of the octocoral.

KEY WORDS
Chionelasmus,
Eolasmatinae,
Balanomorpha,
Cirripedia,
New Caledonia,
Southwest Pacific.

RÉSUMÉ

Une nouvelle balane de Nouvelle-Calédonie du genre Chionelasmus (Cirripedia, Balanomorpha) associée à un octocoralliaire. Le genre *Chionelasmus* était jusqu'à présent considéré comme monospécifique et *Chionelasmus crosnieri* n.sp. est maintenant décrite du Banc Éponge, un guyot de la partie septentrionale de la Ride Norfolk, au sud de la Nouvelle-Calédonie. Cette nouvelle espèce est associée à un octocoralliaire du genre *Muricides* et le mode de pénétration de la larve cypris vers son squelette axial est discuté.

MOTS CLÉS
Chionelasmus,
Eolasmatinae,
Balanomorpha,
Cirripedia,
Nouvelle-Calédonie,
Sud-ouest Pacifique.

INTRODUCTION

The first known species of *Chionelasmus*, *C. darwini* was described by Pilsbry (1907), from 417-430 metres off the Hawaiian Islands. Since that time, the distribution of the genus has been extended to the Indian Ocean (Nilsson-Cantell 1928; Yamaguchi 1998), and the Southwest Pacific (Kermadec Islands) (Foster 1981). The fossil record is now known to extend back to the Eocene (Buckeridge 1983; 1993). This paper examines further living material, recovered by Bertrand Richer de Forges, from the northern part of the Norfolk Ridge.

The specimens studied here are preserved in alcohol, and have been examined with the aid of microscopy and dissection. In addition to scanning electron microscope photographs of the exterior of the holotype, illustrations of opercula, mouth parts and appendages have been drawn with the aid of a camera lucida.

The holotype MNHN-Ci 2685, and paratypes MNHN-Ci 2686 to Ci 2688 inclusive, are deposited in the Muséum national d'Histoire naturelle (MNHN), Paris, France; a further paratype, CAX 118, is held in the type collections at the UNITEC Institute of Technology, Auckland, New Zealand.

SYSTEMATICS

Subclass CIRRIPEIDIA Burmeister, 1834
Order SESSILIA Lamarck, 1818
Suborder BALANOMORPHA Pilsbry, 1916
Superfamily CHIONELASMATOIDEA
Buckeridge, 1983

Family CHIONELASMATIDAE Buckeridge, 1983

DISTRIBUTION. — Upper Palaeocene to Eocene (New Zealand); Recent, 207-1180 m (Pacific Ocean).

DIAGNOSIS

Shell of six primary wall plates: rostrum (R), carina (C), and two pairs of dedicated latera, rostrolatera (RL) and carinolatera (CL), all in contact with the substrate and surrounded by distinctly separate whorl(s) of basal imbricating

plates; sheath formed by R, C and CL; RL not entering sheath; basis thinly calcareous.

REMARKS

The exclusion of the RL from the sheath is a useful indication of antiquity, being characteristic only of the Chionelasmatoidea and the most primitive Pachylasmatoidea: *Waikalasma*, *Eolasma* and *Pachylasma* (Buckeridge 1996a, b).

Genus *Chionelasmus* Pilsbry, 1911

TYPE SPECIES. — *Chionelasmus darwini darwini* (Pilsbry, 1907). Recent, 207-450 m, North Pacific Ocean.

SPECIES INCLUDED. — Two living species are presently attributed to this genus, one being further divided into two subspecies: *Chionelasmus darwini sensu stricto* (Pilsbry, 1907), North Pacific Ocean (207-450 m); *Chionelasmus darwini* n.subsp. (Yamaguchi, 1998), Indian Ocean (420-526 m); plus the new species described here: *Chionelasmus crosnieri* n.sp., Southwest Pacific Ocean (505-1180 m).

DISTRIBUTION. — Upper Palaeocene to Eocene (New Zealand); Recent, 207-1180 m (Indian and Pacific Oceans).

DIAGNOSIS

Chionelasmatinae with trimorphic basal imbricating plates, which, although attributable to up to four whorls, are integrated into one.

REMARKS

Chionelasmus differs from *Eochionelasmus* Yamaguchi, 1990 primarily in the nature of the imbricating whorls (Yamaguchi & Newman 1990). In *Eochionelasmus*, there are between five and nine distinct whorls of imbricating plates, however these plates are monomorphic, lacking the alar extensions characteristic of *Chionelasmus*.

Chionelasmus crosnieri n.sp.
(Figs 1-5)

MATERIAL EXAMINED. — **New Caledonia.** BERYX 11: STN CH02, 24°57'S - 168°21'E, 505-600 m, 14.X.1992: 5 specimens attached to a decorticated octocoral. — Stn CHO5, 24°54'S - 168°22'E, 600-650 m, 15.X.1992: 8 specimens embedded in the living octocoral *Muricides* sp. indet.

RECORD. — Foster (1981: 354), 1180 m. Material lost, opercula and body parts not figured by Foster (*loc. cit.*).

TYPE SPECIMENS. — Holotype, MNHN-Ci 2685: complete shell, with complementary male on operculum, from stn CH05 (Fig. 1); soft tissue removed and prepared for drawing and SEM photography. Paratypes: MNHN-Ci 2686, one complete shell, from stn CH05, with soft tissue and opercula removed; MNHN-Ci 2687, 5 specimens, 4 complete, from stn CH05; MNHN-Ci 2688, 5 specimens, 4 complete from stn CH02; CAX 118: 1 specimen from stn CH05.

ETYMOLOGY. — The new species is named to honour Dr Alain Crosnier, ORSTOM (Institut Français de Recherche Scientifique pour le Développement en Coopération), Muséum national d'Histoire naturelle, Paris. On two separate occasions, 1993 and 1996, I

have had the privilege of working in Paris with Alain. He is one of a special breed of scientists, who through scientific rigor, professionalism and dedication, leaves a legacy with ORSTOM that is unlikely to be equalled. I am proud to be able to call Alain both a much respected colleague in science, and a friend.

HABITAT. — Stations CP CH02 and CH05 are located on the flat, limestone capped summit of a large guyot, known as Seamount B, or "Sponge Bank". Seamount B is part of a lineament of guyots at the northern part of Norfolk Ridge, to the south of New Caledonia. Water temperatures at 600 metres are 10–12 °C. In addition to stylasterids, and octocorals with cirripedes, the site is known for a very rich and diverse sponge fauna, including lithistids, tetractinellids, demosponges. More than 190 invertebrate species have been recorded from the site (Bertrand Richer de Forges, pers. comm.).

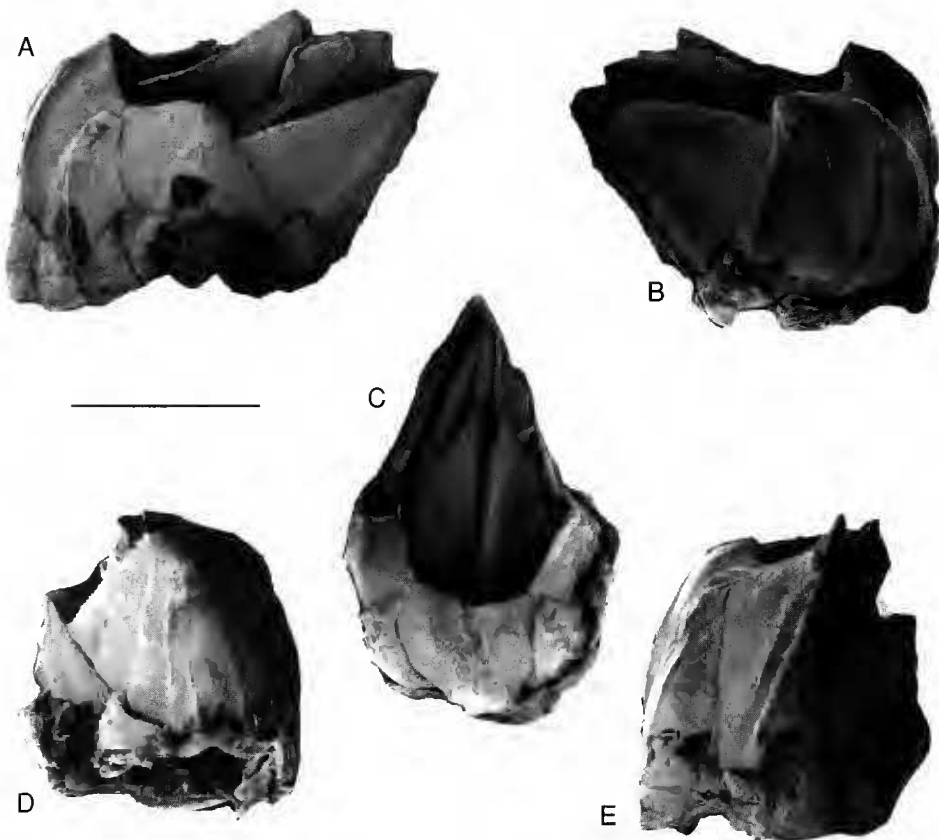


FIG. 1. — *Chionelasmus crosnieri* n.sp., holotype, MNHN-Ci 2685; A, lateral view of whole specimen, with complementary male attached near apex of tergum (right side); B, lateral view of whole specimen (left side); C, dorsal view of whole specimen; D, carinal view of whole specimen; E, rostral view of whole specimen. Scale bar: 5 mm.

DIAGNOSIS

Tergum with broadly rounded, well-defined spur; scutum with protruding articular ridge extending half length of tergal margin; cirrus VI with four pairs of setae on anterior edge of intermediate segments.

DESCRIPTION

Holotype (MNHN-Ci 2685): rostro-carinal diameter 12.4 mm; width 9.1 mm; height 8.7 mm. Paratype (MNHN-Ci 2686): rostro-carinal diameter 11.4 mm; width 9.7 mm; height 12.5 mm.

Shell white, porcellanous; base calcareous, very thin centrally, but thickened nearer paries, with short but weak terminal ribs or extensions; carina well developed, semi-conic, with extended alae, approximately twice height of rostrum. RL and CL clearly separated from paries of rostrum and carina respectively by broad exposed alar areas on latter plates; internally, RL not entering the sheath. Primary plates transversely sculptured with fine growth lines, each paries with central, very weakly-developed longitudinal ribs, rib spacing approximating apices of basal imbricating

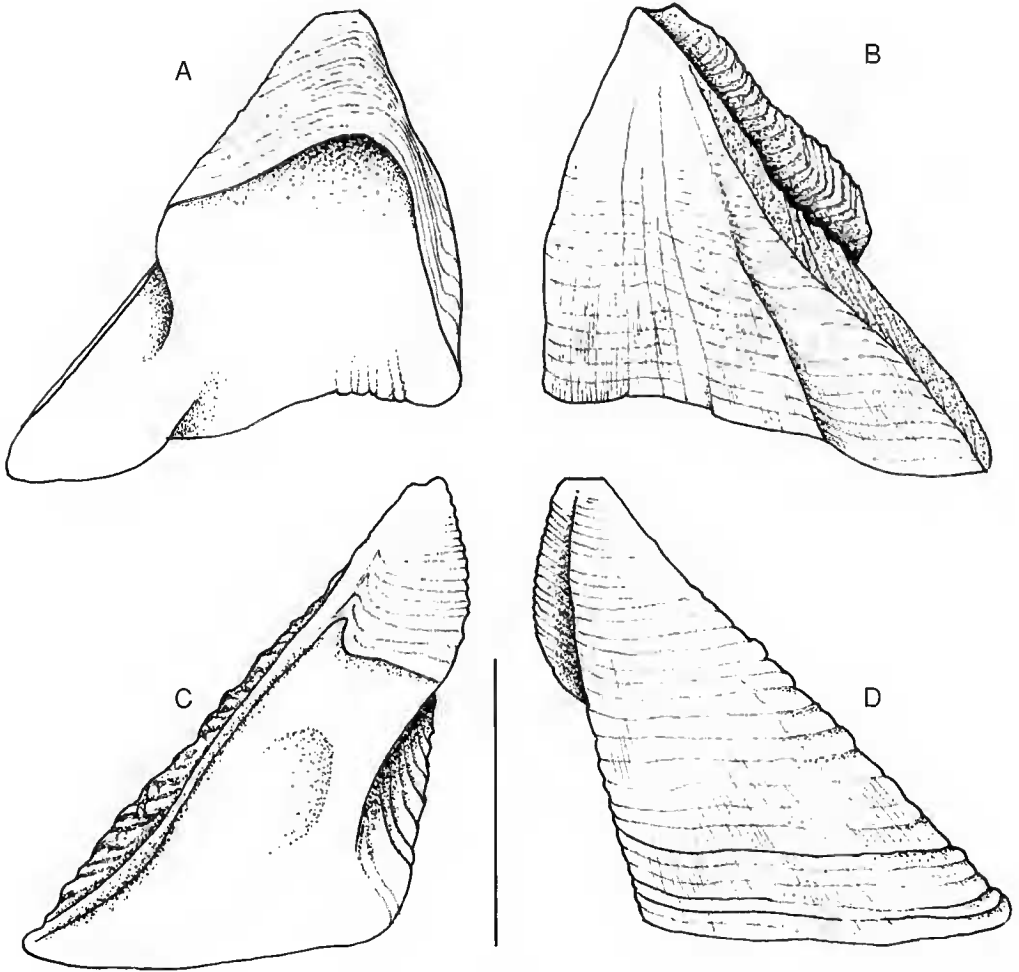


FIG. 2. — *Chionelasmus crosnieri* n.sp., paratype, MNHN-Ci 2686; A, tergum (right), interior; B, same, exterior; C, scutum (right), interior; D, same, exterior. Scale bar: 4 mm.

plates; growth lines slightly basally deflected approaching parietal ribs. Alae almost confluent with paries, possessing very fine apico-basal striae transversely between well spaced growth lines, wetting absent. Interior of carina with low, narrow rib along alar margin. Imbricating plates trimorphic, two types have "alar extensions" or

overlapping margins (either on one, or both sides), one type lacks alar extensions; alar extensions with well formed, subvertical, growth lines; imbricating plates and base of parietal plates in contact with substrate; base of paries slightly inflected inwards.

Opercula (Fig. 2): tergum triangular, basal mar-

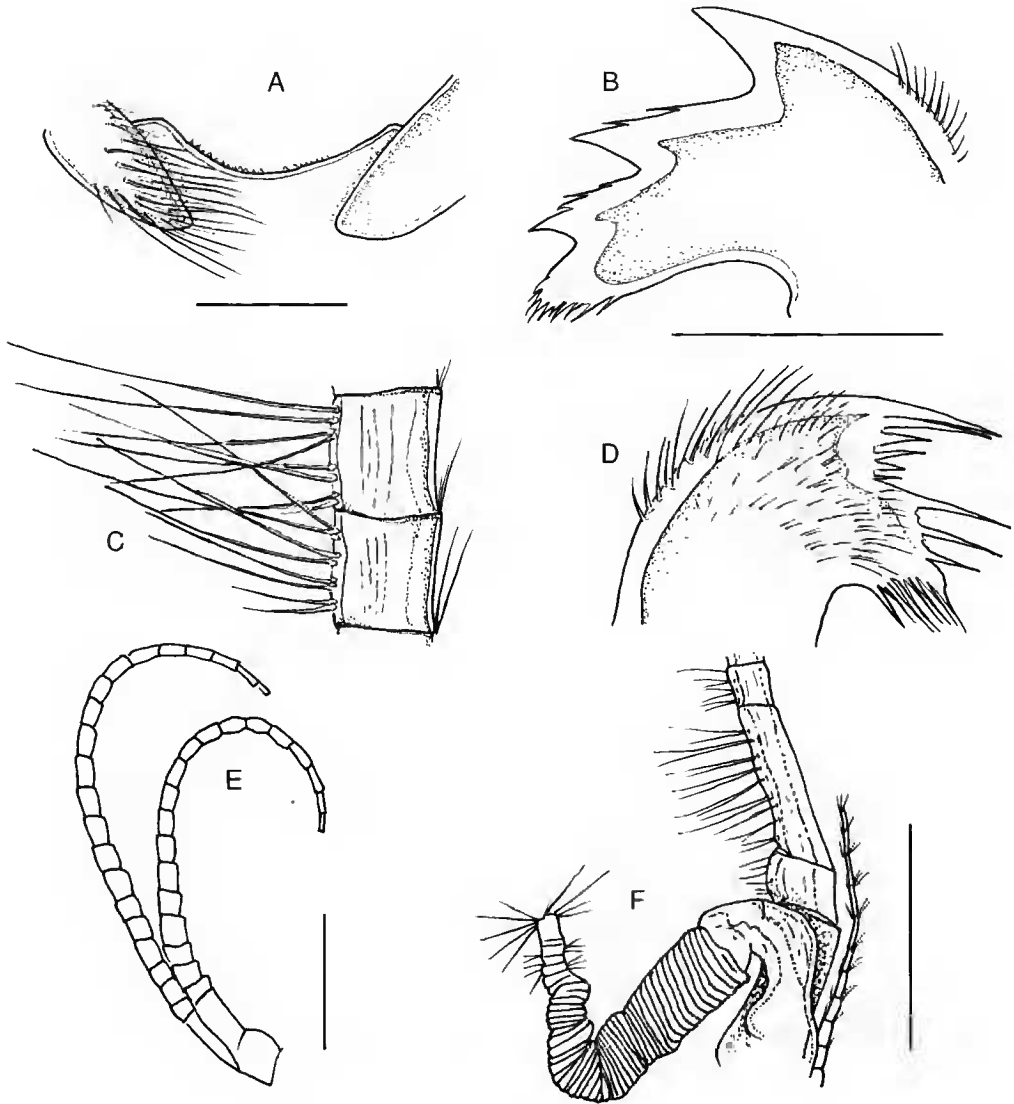


FIG. 3. — *Chionelasmus crosnieri* n.sp., holotype, MNHN-Ci 2685; A, labrum and palps (setae shown on left palp only); B, mandible (right side); C, intermediate segment of cirrus VI showing setal arrangement (right side); D, first maxilla (left side); E, cirrus III (left side, shown with setae removed); F, caudal appendage, penis and basal portion of cirrus VI. Scale bars: A-D, 0.5 mm; E, F, 2 mm.

gin slightly concave, carinal margin slightly convex; exterior with well-developed transverse growth lines crossing strong apico-basal striae, and fine, delicate, apico-basal micro-striae; apico-basal furrow projected as broad, moderately rounded spur at basi-scutal angle; interior with elevated articular ridge; articular furrow moderately deep; crests for depressor muscles moderately developed near basi-carinal angle. Scutum triangular, basal and tergal margins broadly and gently convex; externally with strong growth lines cut by fine apico-basal micro-striae; protruding articular ridge extending half length of tergal margin; internally with weakly-developed, centrally placed, adductor muscle pit; articular ridge elevated with strong transverse growth lines.

Body parts (Fig 3): mandible tridentate, outer edges of second and third teeth with occasional, fine, flattened serrations, inner angle pectinate with numerous short spines; first maxilla with two large upper spines, notch poorly-developed, centrally with group of three large spines, lower angle with numerous smaller spines, relatively hirsute overall; second maxilla bilobed. Penis long, basal third smooth, non-hirsute, outer two thirds annulated, hirsute at end; labrum broadly curved, with numerous small, but well-formed, centrally disposed teeth; palps moderately sharply rounded, with setae primarily on inner side, well-separated.

Cirrus I anterior and posterior rami about equal number of segments. Cirrus II more like cirrus III than cirrus I. Anterior rami of cirri III, VI, V and VI slightly shorter in length than posterior rami, although occasionally with more segments. Cirrus VI with intermediate segments having four pairs of setae on the anterior edge; caudal appendages about twice length of basal pedicel of cirrus VI. For holotype, segments per rami, (first line from cirri on right side, anterior ramus first), and for caudal appendages (c.a.) as follows:

I	II	III	IV	V	VI	c.a.
9/10	15/17	20/21	26/28	27/26	25/28	11
10/10	15/18	21/21	26/23	25/26	23/25	12

Colour (in alcohol): the holotype and paratype shells are presently creamy-white internally and

externally. Some soft tissue in the holotype has a straw tinting, e.g. the chitinous cutting edges of the mouth parts.

REMARKS

This species is unusual in the choice of an octocoral for its host. Specimens from station CH05 are deeply embedded in the coral, with soft tissue covering all but the orifice and opercula (Fig. 5). Yamaguchi (1998) places much emphasis on the disposition, and the number of imbricating plates (see Fig. 4). The number of imbricating plates in *C. crosnieri* varies ontogenetically, and in some specimens may differ slightly on each side of the shell [e.g. the largest specimen from Ci 2688 (R-C diameter: 9.1 mm) has an extra plate "c" on the left side].

The fine, basal ribbing (or nodes) on the parietal plates was initially thought to have been a function of the substrate surface pattern. The specimens grow however, on a cylindrical structure, with a longitudinal surface texture. As such, the ribbing could be expected to be linearly arranged. That they are radial in overall disposition indicates that ribbing is a primary feature.

It is unfortunate that the material described by Foster (1981), from the Kermadec Islands, has been lost from New Zealand's oceanographic collections (held at the National Institute of Water

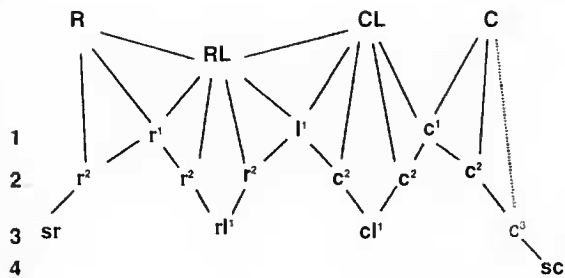


FIG. 4. — *Chionelasmus crosnieri* n.sp. The arrangement of wall plates in adult specimen. Parietal plates: R, rostrum; C, carina; RL, rostrolatus, CL carinolatus. Basal imbricating plates: r¹, imbricating plate added between R and RL; c¹, imbricating plate added between RL and C; r², c², imbricating plates of second tier, variously disposed as shown; sr and sc, imbricating plates added directly below R and C; r¹' and c¹' imbricating plates added directly below RL and CL; c³ (not in bold), imbricating plate occasionally found below c² and C. Numerals down left hand side indicate "whorl number" of imbricating plates. If c³ present, sc would fall into a fourth whorl.

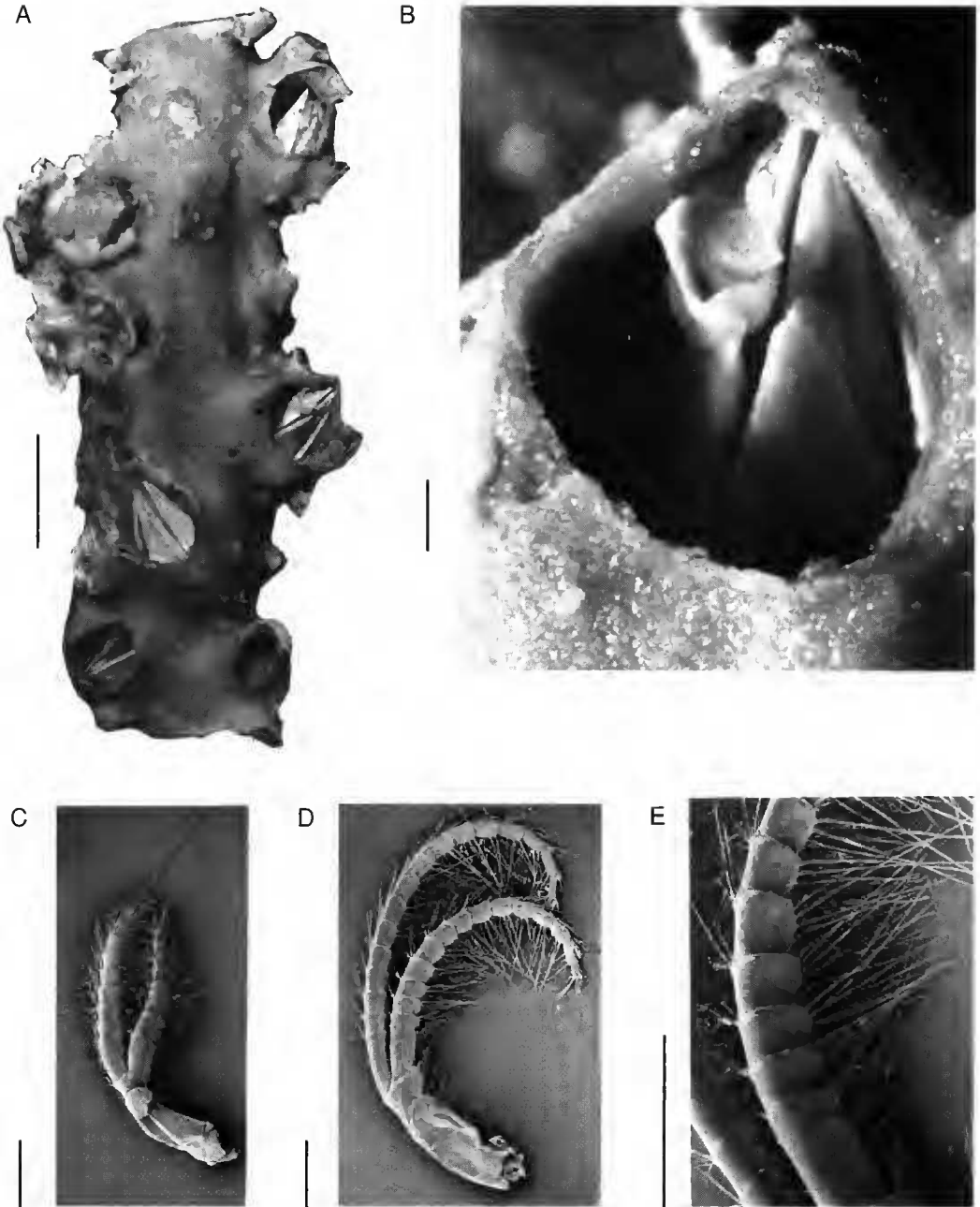


FIG. 5. — *Chionelasmus crosnieri* n.sp.; A, the relationship of *C. crosnieri* n.sp. with the host octocoral, *Muricides* sp. indet. (Paratype, MNHN-Ci 2687); B, detail of specimen central right of A, showing attached juvenile (damaged), most of the shell, apart from that closest to the orifice is buried within the coral tissue; C, cirrus I (left side, SEM photograph); D, cirrus II (left side, SEM photograph); E, detail of D, showing basal portion of anterior ramus of cirrus II (SEM photograph). Scale bars: A, 10 mm; B-E, 1 mm.

and Atmospheric Research, Wellington). Although Foster did not publish figures of body parts and opercula, he did prepare working diagrams, and these have been made available by courtesy of Professor T. Yamaguchi. The mandible, first maxilla, caudal appendages and penis conform to the holotype of *C. crosnieri* n.sp., but there are no known figures of the labrum or palps. There are slight variations with the opercula, but these differences are interpreted as ontogenetic, Foster's material being juvenile. Nonetheless, the tergum of Foster's material possessed a concave basal margin, and the scutum had an articular ridge that extended for about half the length of the articular margin. These characters, supported by the geographic location of the specimen, are considered sufficient to place the Kermadec Islands material within *C. crosnieri* n.sp.

Specimen MNHN-Ci 2685 (Fig. 1) possesses a small barnacle, attached near the apex of the right tergum (R-C diameter: 2.3 mm). This grew initially within the articular furrow, but with ontogeny, now occupies a larger area on the tergum. Both terga and scuta of this barnacle possess dimpled apical primordial valves. Only the first of the imbricating plates (C^1) is present, with the primary wall of the shell being comprised of six parietal plates (*i.e.* R-RL-CL-C-CL-RL). This arrangement corresponds to that of an early postlarval stage (Newman 1987: fig. 6B), rather than that of a complemental male (as in Hui & Moyse 1984).

HOST RELATIONSHIPS

Chionelasmus crosnieri n.sp. is commensal on an octocoral, *Muricides* sp. indct. It is not attached to the surface of the octocoral however, but to the axial skeleton. Except for the opercula and the apical parts of the carina and rostrum, no part of the barnacle shell is visible, *i.e.* it lies buried within the soft tissue of the coral (Fig. 5). The mechanism by which cyprid larvae gain access to the axial skeleton is unknown, as it is uncertain whether they could burrow through coral tissue. Observations, however, have been made on barnacle commensals on gorgonians living off La Jolla, California (Gomez 1973). Gomez proposed that cyprid larvae of *Balanus*

galeatus gained access to the axial skeleton after nudibranch feeding exposed the axis. The barnacles were generally found terminally on coral branches, the preferred sites for nudibranch predation, suggesting that the cyprids attached themselves to the axis during, or shortly after, nudibranch feeding. A similar mechanism may provide an opportunity for *C. crosnieri* cyprids to gain access to the axis of *Muricides*.

AFFINITIES

Chionelasmus crosnieri n.sp. closely resembles *Chionelasmus darwini* (Pilsbry), but may be distinguished from that species by the opercula and body parts. The tergum in *C. crosnieri* n.sp. has a more obtuse apical angle, a broader, more clearly defined spur with a less acute basal angle; the scutum is broader, with the protruding articular ridge extending for about half the length of the tergal margin, it has a basal margin that is broadly convex (rather than concave or sinuous), and a moderately acutely rounded basi-occludent angle. Cirtus VI has four pairs of setae on the anterior edge of intermediate segments (*C. darwini* has five). The mandible lacks the medium-sized secondary teeth that occur in *C. darwini*, and the first maxilla possesses only two upper spines, with numerous fine setae below the lower angle. The penis is only annulated over two thirds of its length, and is only hirsute at the tip (*C. darwini* is annulated and hirsute over the entire length).

This species is similar to specimens of Eocene age from the Chatham Islands, figured in Buckeridge (1983: 61), as *Chionelasmus darwini*. Unfortunately very few opercula have been recovered from the fossil material. Of particular note is the tergal margin of the scutum, which has the protruding tergal ridge extending for about two thirds of its length. This character serves to distinguish the fossil material from all living forms, and places it closest to *C. crosnieri* n.sp. It is hoped that further collecting will clarify the systematic location of the Chatham Islands material, although at present, it seems most likely that it will be placed within *C. crosnieri* as a further subspecies.

C. crosnieri is readily distinguished from *Eochionelasmus obtai* Yamaguchi, 1990, by

having less than five whorls of imbricating plates, a scutum which possesses an almost 90° basi-tergal angle (*E. obtai* is broadly rounded) and a tergum, which in *E. obtai* has a more deeply excavated basal margin. The mouth parts of *E. obtai*, unlike *C. crosnieri*, possess distinctive features that are interpreted by Yamaguchi & Newman (1990) as adaptations for living in a hydrothermal environment.

BIOGEOGRAPHY

The Southwest Pacific has been interpreted by Buckeridge (1996a), as a centre of Sessilian evolution during the early Cainozoic. Many primitive sessilian cirripedes are first recorded from this part of the world, e.g. *Chionelasmus* is first known from the Eocene of the Chatham Islands [it is also known from the Eocene of Tonga, although detail of this location is unpublished (Yamaguchi & Newman 1990)]. If the Southwest Pacific is confirmed as the centre for chionelasmatoïd speciation, this speciation occurred after the breakup of Gondwana. If this is so, long range dispersal during the mid-Cainozoic, rather than vicariance, is the most likely mechanism for *Chionelasmus* to have colonized the Indian Ocean and northern Pacific.

Acknowledgements

The author wishes to sincerely thank Dr. Crosnier for the invitation to work on the MUSORSTOM collections, and for access to the material. Professor William A. Newman, Scripps Institute of Oceanography, La Jolla, CA, and Professor Toshiyuki Yamaguchi, Chiba University, Japan, provided thoughtful comments, via e.mail during the preparation of the manuscript. Mme Marie-José D'Hondt identified the octocoral, and Dr Daniëlle Defaye (both of Muséum national d'Histoire naturelle, Paris) provided station site data and helpful comments.

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Addendum

One of the referees of this manuscript, Diana S. Jones, has advised that she has a paper in press with the MUSORSTOM series entitled "Cirripedia Thoracica: New Species of Chionelasmatoidea and Pachylasmatoidea (Balanomorpha) of New Caledonia, Vanuatu and Wallis

and Futuna Islands, with a review of all currently assigned taxa". This paper includes reference to *Chionelasmus darwini* Nilsson Cantell from the Southwest Pacific, but does not split the species. In light of this work, Jones' paper and Yamaguchi (1998), an opportunity exists for further analysis of the genus as a whole.